JUN 2 1987

8.4.3

DRAFT
ENGINEERING EVALUATION/COST ANALYSIS
GUIDANCE
FOR
NON-TIME-CRITICAL
REMOVAL ACTIONS

"REVIEWED FOR CLASSIFICATION
By R. B. Hoffman
Date 6-10-92

"REVIEWED FOR CLASSIFICATION
By [signature]
Date 6/8/90

ADMIN RECORD

A-SW-000005

TABLE OF CONTENTS

1.0 INTRODUCTION

An engineering evaluation/cost analysis (EE/CA) is a comparative analysis of removal action options for a Superfund hazardous waste site. The EE/CA process is the procedure used by response personnel to develop, evaluate, and select a removal action. The EE/CA report is the document that records this analytical process. A formal EE/CA report is required for all non-time-critical removal actions/expedited response actions (ERAs).[1] For other removal actions, site documents (e.g., Action Memoranda, POLREPS, OSC reports) should be expanded to provide better documentation of the analysis of removal action options. To the extent possible, such documents should address the major elements of the formal EE/CA, as described in this guidance.

This document provides guidance on the EE/CA process and report, and is intended for use by EPA and State personnel, removal contractors, and remedial contractors involved in removal activities. This guidance supplements existing removal program requirements, as defined by the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), the Superfund Amendments and Reauthorization Act of 1986 (SARA), the National Oil and Hazardous Substances Contingency Plan (NCP),[2] the Superfund Removal Procedures, and other removal program policies and procedures. The EE/CA guidance should be used in conjunction with, and not as a substitute for, these other requirements.

The remainder of Section 1 briefly describes the EE/CA contents and discusses factors affecting the EE/CA scope and timing. Section 2 details the EE/CA procedure. Sections 3, 4, and 5 address contracting, cost management, and funding issues, respectively.

---

[1] ERAs are non-time-critical removal actions taken at NPL sites by remedial contractors, overseen by a Remedial Project Manager (RPM). For more information on ERAs, see "The Role of Expedited Response Actions Under SARA," April 21, 1987 (OSWER Directive #9360.0-15).

[2] The National Contingency Plan for Oil and Hazardous Substances (NCP) (40 CFR 300.65) is currently being revised by EPA Headquarters pursuant to SARA.

The EE/CA will be used to satisfy four goals:

1. To provide a methodology for evaluating and selecting an alternative technology for waste disposition to ensure that the technology is sound and appropriate for the specific site;[3]

2. To fulfill the requirements of the National Environmental Policy Act (NEPA) for non-time-critical removal actions/ERAs;[4]

3. To provide improved documentation for removal action selection to facilitate cost recovery efforts;

4. To provide better documentation of the decision-making process for removal actions for inclusion in the administrative record.

All EE/CAs will include the same basic elements, but because the EE/CA will be used to satisfy a number of different goals, the scope and level of detail will vary.

1.1 EE/CA CONTENTS

The basic components of an EE/CA are outlined below. Section 2 of this guidance document explains each of these components in detail.

- Site characterization
- Identification of removal action objectives
- Identification of removal action alternatives

---

[3] See the "Administrative Guidance for Removal Program Use of Alternatives to Land Disposal," (date) (OSWER Directive #9380.2-1).

[4] See the removal program policy on compliance with NEPA, "Environmental Review Requirements for Removal Actions," April 13, 1987 (OSWER Directive #9318.0-05).

- Initial screening of removal action alternatives

  -- Screening factors

  1. Timeliness. Is the option timely with respect to threat mitigation?

  2. Protectiveness. Is the option protective of human health and the environment?

  3. Technical feasibility. Is the option an emerging technology? (Emerging technologies will be ruled out.) Is there some technical aspect of this option that would make it inappropriate?

  4. Institutional considerations. Are there any overriding institutional considerations that would eliminate the option?

- Analysis of remaining removal action alternatives

  -- Selection criteria
  1. Technical feasibility
  2. Reasonable cost
  3. Institutional considerations
  4. Environmental impacts.

- Comparative analysis of removal action alternatives

- Recommended removal action alternative

1.2 SCOPE AND TIMING

The EE/CA should evaluate final waste disposition for the site. Waste disposition can include treatment, recycling, or disposal. For removal sites that do not involve waste

disposition, such as provision of an alternate water supply,[5] the EE/CA should evaluate the final removal solution at the site.

Removal program policy[6] establishes three categories of removal actions based on the urgency of the response: 1) classic emergencies, 2) time-critical removal actions, and 3) non-time-critical removal actions. Classic emergency removal actions are defined as actions that, based on the threat to public health, welfare, and the environment, must be initiated within hours or days after completion of the site evaluation. Time-critical removal actions are defined as actions that, based on the threat to public health, welfare, and the environment, must be initiated within six months after approval of the Action Memorandum. Non-time-critical removal actions/ERAs are defined as actions that, based on the threat to public health, welfare, and the environment, may be delayed for six months or more before the Action Memorandum is approved and on-site cleanup is initiated. A formal EE/CA report is required only for non-time-critical removal actions/ERAs. However, as noted earlier, site documentation for other removal actions should be expanded to provide a better record of the decision-making process.

The sequence of events for preparation of an EE/CA for non-time-critical removal actions is outlined below. Each step is then explained in greater detail. Note that preparation of the EE/CA Approval Memorandum follows the site evaluation. At an NPL site, the need for a non-time-critical removal action/ERA may be identified later in the process than the initial site evaluation, for example, during the RI/FS or implementation of the remedial action itself.

- Site evaluation
- Preparation and approval of EE/CA Approval Memorandum
- Additional site activities to better define the site and characterize waste, if necessary
- Preparation of EE/CA report
- Public comment period
- Preparation and approval of Action Memorandum, including responsiveness summary

---

[5] OERR is developing EE/CA procedures tailored specifically for these types of actions, titled "Guidance Document for Providing Alternate Water Supplies."

[6] See "Environmental Review Requirements for Removal Actions" (footnote 4).

- Implementation of approved removal action
- Change in scope of work, if necessary

Site evaluation. The site evaluation consists of an assessment of the threat at the site to determine if a Federally-funded removal action is necessary and, if so, whether the response is a classic emergency, time-critical, or non-time-critical. Procedures for performing a site evaluation are described in the NCP and Chapter ____ of the Superfund Removal Procedures. The site evaluation for non-time-critical removal actions is basically the same as for other removal actions, except that additional time is available to collect more in-depth site information. Once the threat is characterized as non-time-critical, response personnel should perform a thorough site evaluation to try to identify all of the threats at the site prior to preparing the EE/CA. A detailed assessment can avoid the need to amend the EE/CA in the future because certain threats were not detected in the original site evaluation. (As noted above, at NPL sites, the evaluation of the need for a non-time-critical removal action/ERA may occur in later phases of the remedial response.)

EE/CA Approval Memorandum. Before an EE/CA is prepared, the decision to implement a non-time-critical removal action at a site must be documented in an EE/CA Approval Memorandum. (See Appendix A for a model EE/CA Approval Memorandum to be used for non-time-critical removal actions/ERAs.) The EE/CA Approval Memorandum should include:

- Background information on the site
- Threats to public health or welfare or the environment
- Enforcement information (not for public release)
- Proposed scope of work and cost (104(b)) for the EE/CA, including any additional on-site activities needed to characterize the waste
- Preliminary estimate of the time and funds necessary to complete the removal response, based on the nature of the site problems and waste volume and characteristics

- Expected change in the situation should no action be taken or should action be delayed[7]
- Important policy issues, as necessary.

Note that the final removal action is not proposed at this time. The purpose of the EE/CA Approval Memorandum is to document that the site meets the NCP criteria for initiating a removal action and the response is non-time-critical, and to secure management approval to conduct the EE/CA. The final removal action will be set forth in an Action Memorandum after the public has had the opportunity to comment on the EE/CA.

To determine the appropriate official for approving the EE/CA Approval Memorandum, use the preliminary estimate of the funds needed to complete the removal action. The Regional Administrator may approve actions up to $2 million, and Headquarters must approve actions expected to exceed $2 million.[8] However, for non-NPL sites that qualify as "nationally significant" or precedent-setting, Headquarters must approve the EE/CA Approval Memorandum regardless of estimated cost.[9]

As soon as the EE/CA Approval Memorandum is approved, the Regional community relations staff must be notified that an EE/CA for public review will have to be prepared. In addition, the administrative record for the site must be opened.

- Additional site activities, if necessary. At some sites, on-site work in addition to the site evaluation may be necessary to better define the site and characterize the wastes as part of the EE/CA process. For example, at a site containing buried drums, it may be more efficient to excavate the drums and stabilize them on site in order to obtain an accurate profile of the waste volume and waste type. At a site containing above-ground tanks, it may be necessary to cut open the tanks to determine the tank

---

[7] This section of the EE/CA Approval Memorandum will be used to satisfy the "no action" alternative requirement of NEPA.

[8] At some NPL sites, the Regional Administrator may be delegated the $2 million exemption authority. Delegation procedures are described in _____.

[9] See removal program guidance for the definition of "nationally significant" action, _____.

contents. These activities must be approved in the EE/CA Approval Memorandum and may be performed concurrent with preparation of the EE/CA. Activities conducted as part of the EE/CA must be limited to those necessary for waste characterization and site definition (104(b) activities). Final cleanup measures may not be taken until the public has an opportunity to comment on the proposed action.

The contractor who performs the site characterization work cannot be used to conduct the final cleanup due to potential conflict-of-interest. For non-time-critical actions performed by removal personnel, some site characterization activities may be conducted by the Technical Assistance Team (TAT). For site characterization activities that cannot be performed by the TAT because it is not within the contract scope of work, the Response Engineering and Analytical Contractor (REAC) (formerly the Environmental Emergency Response Unit (EERU)) or other contractor must be used rather than the Emergency Response Cleanup Services (ERCS) contractor. (See Chapter 3 on contracting considerations.) Use of the REAC, where the activities are designated as 104(b) activities, prevents the start of the removal time clock. If the REAC is used to assist in EE/CA activities, however, they may not be used to perform the final cleanup due to potential conflict-of-interest.

EE/CA Report. Using the information obtained thus far, an EE/CA report should be prepared according to the guidance presented in Section 2 of this document. As removal action alternatives are developed and evaluated, it may also be necessary to collect more site information. Data gathering may continue concurrently with preparation of the EE/CA report. The EE/CA report will recommend a final removal action and will be the document released for public comment.

Public comment. The EE/CA report will be made available for public comment for a minimum of 21 calendar days.[10] The Region should consider granting a request for a reasonable extension of this time period if such a request is received within the public comment period, and the request is justified. A public meeting may also be held, if the Region believes it is appropriate based on the nature of the site problem and community interest, or if significant requests are made. The Regional community

[10] The proposed NCP revision, scheduled for publication in the Federal Register in July, 1987, would extend the minimum public comment period to 30 days.

relations staff will be responsible for making arrangements for public notice and review of the EE/CA and, if necessary, for the public meeting. If a public meeting is held, a transcript of the meeting must be prepared. Regional response personnel should support the community relations staff in this effort.[11]

Action Memorandum, including responsiveness summary. After the close of the public comment period, an Action Memorandum must be prepared to describe the final removal action.[12] The Action Memorandum should include a refined estimate of the cost and duration of the removal action. The appropriate approving official should be determined based on this new estimate. "Nationally significant" actions at non-NPL sites, however, must be approved by Headquarters. The Action Memorandum should also include a section describing how the removal action will contribute to the efficient performance of the remedial action to be taken.[13]

In addition, the Action Memorandum must include, as an attachment, a responsiveness summary. The responsiveness summary is a summary of the significant public comments and EPA's response to these comments. Any differences between the final removal action and the action recommended in the EE/CA must be explained. Regional response personnel should work closely with the community relations staff in preparing the responsiveness summary.

After the Action Memorandum is signed, a notice of availability of the Action Memorandum and the responsiveness summary must be published in a major local newspaper before the commencement of the removal cleanup, and these documents must be made available to the public.

Implementation of approved removal action. The approved removal action is then implemented. The statutory limits on removal actions apply only to this portion of the

---

[11] Additional procedures for conducting public review of the EE/CA report are included in _____.

[12] See the Superfund Removal Procedures for instructions on preparing an Action Memorandum.

[13] See removal program "Guidance on Implementation of the "Contribute to Remedial Performance" Provision," April 6, 1987 (OSWER Directive #9360.0-13).

removal action, not to previous 104(b) activities associated with preparation of the EE/CA.

Change in scope of work, if necessary. After the Action Memorandum is signed, if any removal action is to be taken that is significantly different from the action contained in the Action Memorandum, the OSC/RPM shall amend the Action Memorandum, prepare an explanation of the differences, and consider the need for an additional public comment period. The need for an additional public comment period must be considered in the following situations:

- A major new threat is discovered that was not in the Action Memorandum, and the threat is non-time-critical.

- The scope of work as set forth in the Action Memorandum changes significantly due to other reasons, and the new action is non-time-critical.

2.0 EE/CA PROCEDURES

This section presents procedures for conducting site-specific engineering evaluations/cost analyses (EE/CAs). Identified are the elements of the EE/CA that should be researched and evaluated prior to initiating a non-time-critical removal action/ERA. In addition, this section presents the general outline that should be followed when writing the EE/CA report. Adherence to this outline will enhance the usefulness of the EE/CA to response personnel in technology transfer. Because situations presented by potential removal actions cannot be generalized to any great extent, the exact level of detail is left to the discretion of the On-Scene Coordinator (OSC)/Remedial Project Manager (RPM) responsible for the site. However, all elements of the EE/CA discussed in this section should be addressed, both procedurally and in the report. It is the responsibility of the OSC/RPM to perform as detailed an evaluation as is appropriate and to properly document such an evaluation.

Each subsection presents a major element of the EE/CA process and corresponds to sections that should be included in the EE/CA report. Section 2.1 describes the type of information that is needed to effectively characterize a site. Section 2.2 discusses factors that influence the identification of removal action objectives. Sections 2.3 and 2.4 describe the process that should be used to identify and then screen appropriate removal technologies. The process by which site alternatives (which may be comprised of several technologies) that survive the screening process are analyzed in greater detail is presented in Section 2.5. Section 2.6 outlines evaluation and presentation techniques that may be used to compare alternatives. Finally, the selection of an alternative is discussed in Section 2.7. Appendix B provides an example of how a removal action could be selected through the EE/CA process defined in this section.

2.1 SITE CHARACTERIZATION

Selecting and justifying an appropriate response action at a site requires an accurate evaluation of the site conditions. The site characterization can also be used to establish a baseline for use in analyzing the environmental impacts of removal actions in accordance with NEPA. Site characterization is the first step in the EE/CA process,

out it may continue concurrently with the remaining steps in the process, as additional information needs are identified. For example, the evaluation of certain technologies may require more detailed information about waste characteristics than was originally collected in the site characterization phase. For documentation purposes, the amount of detail included in the site characterization depends on the complexity of the site.

Because the EE/CA report will be prepared after the EE/CA Approval Memorandum is approved, much of the information necessary for the site characterization will be available from the Approval Memorandum itself. In addition, existing site documents, such as site evaluation studies, Site Inspection Reports (EPA Form 2070-13), remedial investigation studies, state and local environmental reports, or published engineering evaluations may contain supplementary information on site characterization. For documentation purposes, existing reports that provide sufficient detail need not be rewritten, but may be referenced and attached to the EE/CA report. The site characterization section of the EE/CA report should also include any relevant information collected during the remaining steps of the EE/CA process.

The format below provides a framework for documenting the site characterization information. The following subsections describe this outline in more detail.

- Site description
- Site background
- Analytical data
- Site conditions that justify a removal action

2.1.1 Site Description

In evaluating current site conditions, any observations made during the site evaluation, preparation of the EE/CA, and review of any previously released reports should be considered. A complete assessment of the physical features of the site, nature and extent of contaminants present, and potential impact of the site should include as many of the following factors as are relevant:

- Site location;
- Type of facility and operational status, if appropriate;

- Current site owners and/or operators;
- Present site use;
- Site use or access restrictions;
- Surrounding land use and population density;
- Distance to and description of nearby sensitive environments and ecosystems;
- Distance to and uses of surface waters and ground water;
- Site topography;
- Geological and geotechnical information;
- Description of contaminants - quantities, concentrations, containment, and extent;
- Potential or actual release of contaminants;
- Potential or actual impacts of the site on adjacent properties and neighboring populations.

In writing the EE/CA report, the relevant factors should be discussed. Photographs and figures should be used whenever possible to indicate the location of important features. Analytical data may be presented with the discussion of contaminants or they may be included in the section on analytical data (Section 2.1.3).

2.1.2 Site Background

A review of the site background can identify hazards that are not apparent during a site inspection, and can indicate potential areas for further investigation. Relevant information concerning threats posed by contaminants on the site, the roles of potential responsible parties, and any other information that may impact the removal action should be evaluated. State, local, and other Federal files may provide much of the information for this section in the form of inspections, complaint reports, and response notes. These documents will often contain the following information:

- Prior site use;
- Operational history - past and present owners/operators;

- Regulatory involvement, including responses, investigations, and litigation by:

  - local agencies - fire and police departments and county health and environmental departments;
  - State agencies - fire marshal and state environmental and conservation agencies/departments; and
  - Federal agencies - U.S. EPA Emergency Response and other U.S. EPA offices or divisions, and other Federal departments and agencies (e.g., Department of the Interior, Department of Defense, Department of Transportation, or U.S. Coast Guard).

The documents from the sources listed above may be summarized and referenced in the site background section of the EE/CA report. Reports containing sampling results and other analytical data, however, may be discussed in the site description section or in the section on analytical data. Confidential information from these sources should not be included because the EE/CA report will be subject to public review.

2.1.3 Analytical Data

In the EE/CA process, analytical data may be generated from several sources. The OSC/RPM will have existing analytical data when the process starts. Additional data may be collected during the site characterization phase of the EE/CA, and finally, more data may be required during the evaluation of individual technologies. In the EE/CA report, all of this data should be summarized in the "Site Description" or "Analytical Data" section for easy reference. Significant findings from the data should be explained in a narrative discussion, including, where appropriate, consideration of the reliability of the data. The actual data can be presented in summary tables either within the section or in an appendix.

Existing analytical data from sources such as site investigations, site evaluations, or studies conducted by other groups (e.g., state or local health or environmental authorities) may be useful in characterizing the threat. The analytical data should be thoroughly reviewed to determine the precision, accuracy, representativeness, completeness, and comparability of the results in previous sampling efforts. These parameters are documented in sampling efforts and laboratory analyses through routine

quality control procedures, such as replicate samples and/or analyses, replicate spiked samples and/or analyses, field blanks, method blanks, and analysis of standard reference materials. Validation and usability of data can be affected by sample matrix, sampling method, contaminant concentration, sampling conditions, analytical methodology, and analytical instrumentation. Any available soil, water, or waste analyses should be evaluated for possible usefulness. Other data, such as air monitoring results, may also be included to substantiate the threats and characterize the site. All data used to justify a response should be supported by quality control data and an evaluation of data quality based on quality assurance documentation. Once the data are of "known quality", they can be compared to existing environmental standards to determine the nature of the threat.

2.1.4 Site Conditions that Justify a Removal Action

Based on the characteristics of the site presented in the previous sections, the conditions that necessitate a response should be described. Again, the information contained in the EE/CA Approval Memorandum may be used for this purpose. Paragraph (b)(2) of Section 300.65 of the NCP lists the following factors that should be considered when determining the appropriateness of a removal action:

(i) Actual or potential exposure to nearby populations, animals, or food chain from hazardous substances or pollutants or contaminants;

(ii) Actual or potential contamination of drinking water supplies or sensitive ecosystem;

(iii) Hazardous substances or pollutants or contaminants in drums, barrels, tanks, or other bulk storage containers, that may pose a threat of release;

(iv) High levels of hazardous substances or pollutants or contaminants in soils largely at or near the surface, that may migrate;

(v) Weather conditions that may cause hazardous substances or pollutants or contaminants to migrate or be released;

(vi) Threat of fire or explosion;

(vii) The availability of other appropriate Federal or State response mechanisms to respond to the release;

(vii) Other situations or factors which may pose threats to public health or welfare or the environment.

The degree to which each of the factors is important differs from site to site. In the EE/CA report, each of the relevant factors should be addressed separately, including an evaluation of the potential impact of the hazard. If appropriate, chemical migration and fate and toxicity may be added to the discussion or presented in a separate subsection.

2.2 IDENTIFICATION OF REMOVAL ACTION OBJECTIVES

The identification of removal action objectives is a critical step in the development of an EE/CA and the efficient conduct of a removal action. The importance of such objectives has been enhanced as a result of the increased scope and sophistication of removals under the Superfund Amendments and Reauthorization Act (SARA).

In essence, removal objectives define the "why," "what," and "when" of a removal action and serve to focus the limited resources of EPA. Within the scope of an EE/CA study, the objectives delineate the limits of acceptable technical performance and institutional factors. It is conceivable that two EE/CAs performed for the same site, under the same circumstances, but with different removal objectives would differ in scope, level of detail, and possibly the ultimate selection of a mitigative approach. For example, designing a response to stabilize a site would require a different approach than designing a response to completely clean up a site.

The remainder of Section 2.2 presents the following categories of objectives that should be considered when developing site-specific removal objectives: statutory limits on removal actions, removal scope, removal scheduling, and criteria and standards to be met.

2.2.1 Statutory Limits on Removal Actions

It is important for the public to recognize that the cost and duration of removal actions are generally limited, by statute, to $2 million and 12 months. At this point in the EE/CA report, a brief description of these statutory limits should be provided, together with a short explanation of the two types of exemptions that are available --

the "emergency" waiver and the "consistency" waiver. As alternatives are later identified and evaluated, consideration will be given to whether the alternative can be completed within the statutory limits, or whether the response could qualify for an exemption to the limits[14].

2.2.2 Determination of Removal Scope

The second step in identifying removal action objectives is to determine the removal scope, i.e., what is to be done or accomplished by the removal action. The broad scope of the project should first be defined. This might be total site cleanup, site stabilization, completion of an operable unit (at NPL sites), cleanup of surface hazardous materials, etc.

The next step is to define more specific objectives which are associated with the specific threats and hazardous substances on site. For example, while cleanup of all surface hazardous substances might be the broad project scope, specific objectives might include final disposition of contaminated soils, transformers, capacitors, drums containing PCB-contaminated oils, and drums containing sodium hydroxide pellets. The development of specific objectives is an integral part of the EE/CA process because these objectives will be used as guidelines to identify appropriate removal technologies, and as standards against which the alternatives will be evaluated. Specific objectives that clearly define the scope of the removal action are particularly important in the following situations:

- When the site poses multiple hazards
- When the removal is to be conducted in phases
- When the removal is to address only a subset of the universe of hazards present.

Definition of the scope of the project must also include consideration of how the removal action would best contribute to the efficient performance of the remedial action to be taken. SARA section 104(b) states that removal actions should, to the extent practicable, "contribute to the efficient performance of any long-term remedial

---

[14] See removal program "Guidance on Implementation of the Revised Statutory Limits on Removal Actions," April 6, 1987 (OSWER Directive #9360.0-13).

action with respect to the release or threatened release concerned."[15] In short, the goal of this provision is to avoid the need for removal restarts by considering the long-term cleanup plan for the site when designing the removal action. For example, if the State plans to begin a long-term remedial action at the site in two years, the removal action should be designed to ensure that any threats that meet the criteria for initiating a removal action in the NCP are either completely cleaned up, or sufficiently stabilized on site to last until remedial actions begin. Response personnel must also consider threats that may arise in that time due to deteriorating site conditions. By adequately addressing all such threats in the first removal action, the likelihood of removal restarts should be reduced. If there are no plans for another party to perform long-term remedial actions at the site (which may be the case for many non-NPL sites), the threats that meet the NCP criteria should be completely cleaned up, if possible, given the statutory limits on removal actions. The scope of the project should therefore be designed to avoid removal restarts, in accordance with this provision of SARA.

2.2.3 Determination of Removal Schedule

The OSC/RPM should determine the general scheduling objectives for the actions to be performed. Scheduling objectives should include consideration of both the start and completion time for the removal action. The start date will be based primarily on the urgency of the threat. Although formal EE/CAs are only required for actions that can be delayed for six months, the nature of the threat may still dictate that action be initiated within one year or some other time period. The start date may also be influenced by other factors, such as weather conditions and the availability of Regional resources. For example, weather can affect the removal schedule if the objective is to implement the removal action before the rainy season begins. The amount of lead time available before the removal must start can be a major factor in evaluating alternative technologies, because implementation of innovative technologies can involve considerable lead time.

---

[15] See removal program "Guidance on Implementation of the "Contribute to Remedial Performance" Provision" (footnote 10).

The completion time should also be estimated for the removal action. Again, the nature of the threat will be the most important consideration. In some cases, it may be necessary to achieve beneficial results within a certain timeframe to ensure adequate protection of public health and the environment. A second important factor to consider is the 12 month statutory limit on removal actions. For sites that are not expected to qualify for one of the exemptions to the limits ("emergency" or "consistency" waiver), the objective should be to select a technology that can be implemented within 12 months. For sites that are expected to qualify for an exemption, the objective should be to select a technology that can be implemented within a reasonable amount of time after the 12 month limit. For example, a technology that requires 5 years to complete would not be consistent with the generally short-term nature of removal actions. As with the start date, factors such as weather and the availability of Regional resources may also affect the completion time.

The amount of flexibility in the removal schedule can vary greatly from site to site. Some sites may require adherence to a strict schedule while others allow wider latitude in start and completion times. The scheduling objectives established for a site can be an important decision criteria to screen and further evaluate removal alternatives based on their individual implementation times.

2.2.4 Compliance With Applicable or Relevant and Appropriate Requirements (ARARs)

It is EPA policy to pursue removal actions that will attain or exceed applicable or relevant and appropriate requirements (ARARs) of other Federal and State environmental and public health laws to the maximum extent practicable, considering the exigencies of the situation.[16] Within the EE/CA framework, the OSC/RPM should develop a comprehensive list of those ARARs for the alternatives being considered, given the unique circumstances at the site being addressed. State ARARs should be identified in consultation with the appropriate State representative. Although it may not be possible to fully attain ARARs, the evaluation of removal technologies should

---

[16] See the "CERCLA Compliance With Other Laws Manual," OSWER Directive ____, for more complete information on removal compliance with ARARs.

consider their ability to achieve compliance with the identified cleanup standards and other requirements.

There are several different types of requirements that may apply to removal actions:

- Ambient or chemical-specific requirements set health or risk-based concentration limits in various environmental media for specific hazardous substances or pollutants. Examples: Maximum Contaminant Levels (MCLs), National Ambient Air Quality Standards.

  These requirements set protective cleanup levels for the chemicals of concern in the designated media, or indicate a safe level of air emission or wastewater discharge when these occur in a removal action alternative. If a chemical has more than one such requirement, the more stringent should be complied with, to the extent practicable.

  There are at present a limited number of actual ambient or chemical-specific requirements. In order to achieve protective cleanups, it may frequently be necessary to consider chemical-specific advisory levels such as Health Effects Assessments or Reference Doses. While not actually ARARs, these chemical-specific numbers may factor significantly into the evaluation of the protectiveness of removal action alternatives.

- Performance, design, or other action-specific requirements set controls or restrictions on particular kinds of activities related to management of hazardous substances or pollutants. These requirements are not triggered by the specific chemicals present at a site, but rather by the particular removal alternatives that are evaluated as part to the EE/CA. Examples: RCRA incineration standards, Clean Water Act pretreatment standards for discharges to publicly-owned treatment works (POTWs).

- Locational requirements set restrictions on activities or limits on contaminant levels depending on the characteristics of a site or its immediate environs. Examples: Federal and State siting laws for hazardous waste facilities, sites on the National Register of Historic Places.

Locational requirements may function like either action-specific or ambient requirements. Removal action alternatives may be restricted or precluded depending on the location of the site and the requirements that apply or relate to it. On the other hand, the presence of a certain chemical at a site may automatically trigger a location standard, such as more stringent limits for chemicals in wetlands.

Note also that SARA Section 121(e) exempts any on-site response action from having to obtain a Federal, State, or local permit. In general, on-site actions need only comply with the substantive aspects of these ARARs, not with the procedural or administrative aspects. However, these requirements should still be identified in the EE/CA.

ARARs can be identified only on a site-specific basis. They depend on the specific chemicals at a site, the particular actions being evaluated, and the site characteristics. The different ARARs that may apply to the site are identified at different points in the EE/CA process:

- Site characterization. During the site characterization phase, ambient/chemical-specific requirements and locational requirements are identified. In addition, the OSC/RPM should determine whether the site wastes are restricted under the RCRA land disposal restrictions (discussed in greater detail below).

- Analysis of removal action alternatives. During the detailed analysis of alternatives, the action-specific requirements are identified.

After the applicable or relevant and appropriate laws are identified, the OSC/RPM must determine whether or not compliance with each of the laws will be possible for the removal action. In making this determination, the OSC/RPM must consider the following:

(1) The exigencies of the situation (emergency nature of the threat may preclude meeting an ARAR in order to protect public health and the environment);
(2) The statutory time limits on removal actions; and

(3) The criteria listed under SARA section 121(d)(4)[17] providing conditions under which ARARs may be waived. These conditions are:

- Interim remedy waiver - the removal action selected is only part of a total site cleanup that will attain such level or standard of control when completed.
- Greater risk to health and the environment - compliance with such a requirement will result in greater risk to human health and the environment than alternative options.
- Technical impracticability - compliance with such requirement is technically impractical from an engineering perspective.
- Equivalent standard of performance - the removal action selected will attain a standard of performance that is equivalent to that required under the otherwise applicable standard, requirement, criterion, or limitation, through use of another method or approach.
- Inconsistent application of State requirements with respect to a State standard, requirement, criterion, or limitation - the State has not consistently applied (or demonstrated the intention to consistently apply) a standard, requirement, criterion, or limitation, in similar circumstances at other response actions.

To the extent that full compliance with ARARs will 1) unduly delay initiation of a removal, 2) cause a violation of the statutory funding or time limits, or 3) qualify for exception under SARA, ARARs need not be deemed "practicable" and need not be fully attained in the removal action. However, OSCs/RPMs should strive to comply with all ARARs that can be attained for less than $2 million and in less than 1 year. If all ARARs cannot be attained at a site, OSCs/RPMs should ensure that the removal action will attain those ARARs which are most crucial to the proper stabilization of the site and to the proper protection of public health and the environment until remedial action can afford additional protection. The reason(s) for not attaining all ARARs must be thoroughly documented.

---

[17] SARA section 121(d)(4) specifically provides these waivers for remedial actions, but they are available to removal actions as well.

This section of the EE/CA report should, at a minimum, identify the ambient/chemical-specific requirements, locational requirements, and land disposal restriction requirements. In addition, this section may discuss whether compliance will be possible, or the compliance discussion may be deferred until the specific alternatives are analyzed.

2.2.4.1 RCRA Land Disposal Restrictions

An important factor that may affect the identification and evaluation of removal action alternatives is whether a waste is subject to the land disposal restrictions (LDR) currently being implemented under RCRA (pursuant to the Hazardous and Solid Waste Amendments of 1984). In general, LDR will be phased in over several years to restrict the land disposal of all RCRA wastes, unless certain treatment standards are met. Although certain CERCLA wastes have been granted exemptions and variances from LDR requirements until November, 1988, OERR policy is to comply with LDR to the degree practicable in the intervening period. For more details on how to determine whether a waste is subject to LDR and how to select an appropriate technology, the OSC/RPM should consult the Removal Program LDR Implementation Guidance.[18] A brief overview of how LDR will affect the evaluation of removal technologies is presented below.

The first step in implementing LDR is to determine if the waste at the site is a restricted waste under LDR. This will require prior knowledge about the source of the waste, or use of certain analytical methods described in the LDR regulations. The determination of whether a site waste is restricted under LDR should be documented in this section of the EE/CA report because this determination will affect the initial search for removal alternatives. The second step in LDR implementation is to determine the appropriate treatment standard for the restricted wastes. The treatment standard should also be identified in this section of the EE/CA. For wastes that are subject to LDR, the regulations will identify a treatment standard which is expressed as either a performance standard or a method of treatment. Both types of standards are based on the best demonstrated available technology (BDAT) for treating a waste. For some wastes, the regulations will only establish a performance standard; any

---

[18] [Citation to be provided]

technology can then be used to treat the waste to the specified standard. These regulations may also identify suitable treatment technologies that may be used, but are not required.

For other wastes, the regulations may specify that a particular technology be used for treatment, such as incineration. However, these regulations will also include a provision that allows any party to submit an application to EPA demonstrating that an alternative treatment method can achieve a level of performance equivalent to that of the BDAT.

The next step in implementing LDR is to determine the appropriate treatment technology. In the EE/CA process and report, this step is first addressed in the identification of removal action alternatives (see Section 2.3). The technologies that are identified will be further screened (Section 2.4) and analyzed (Section 2.5) to determine whether they comply with LDR requirements.

The last step in the LDR process is to determine whether the implemented technology has achieved LDR treatment standards. This step will take place during the performance of the removal action itself.

2.3 IDENTIFICATION OF REMOVAL ACTION ALTERNATIVES

Based on the objectives developed in the previous section, technologies that are appropriate for addressing the cleanup objectives established in Section 2.2.2 should be identified. It may be necessary to develop different sets of alternatives for different waste streams on site. Once identified, these technologies should then be screened using the process outlined in Section 2.4. The process of identifying technologies should draw upon previous experience with the technologies and the contaminants to be mitigated as well as knowledge of potential uses of the technologies. Information on potential removal technologies may be obtained from EPA sources such as the Superfund Technology Transfer Program, the Superfund Innovative Technology Evaluation Program, the Removal Alternative Technology List, the Superfund Regional Technology Transfer Contact, best demonstrated available technologies (BDATs) to treat wastes banned from land disposal identified by the EPA Office of Solid Waste, or from

industry publications.[19] Examples of removal technologies associated with different waste matrices are shown in Table 2-1 and Table 2-2. In addition to removal technologies, institutional controls[20], such as curtailing certain types of land use at a site by a deed restriction, may also be considered when identifying removal action alternatives.

In accordance with the "Administrative Guidance for Removal Program Use of Alternatives to Land Disposal,"[21] the OSC/RPM should identify appropriate technologies based on the following three waste categories: 1) recyclable/recoverable materials; 2) wastes restricted from land disposal; and 3) all CERCLA wastes not otherwise restricted, and all RCRA wastes not included in Categories 1 and 2. Category 1 wastes will generally be required to be recycled/recovered. Category 2 wastes will require pretreatment prior to land disposal, an alternative to land disposal, or disposal at a specific type of facility (e.g., TSCA-permitted). Direct land disposal may be among the options considered for Category 3 wastes.

Category 2 wastes may include wastes that are restricted from land disposal under LDR. The LDR requirements should be met to the degree practicable. If the regulation for the restricted waste only specifies that a performance standard must be met prior to land disposal, the OSC/RPM may identify any technologies that seem appropriate for meeting the standard. The OSC/RPM should consider whether any technologies that may be recommended in the regulation are suitable for the wastes on site.

If the regulation for the restricted waste specifies that a particular technology, such as incineration, must be used to treat the waste, the EE/CA must, at a

---

19 OERR is developing a "Technology Screening Guide for Treatment of Contaminated Soils, Solids, and Sludges," ___(date)___ (OSWER Directive #).

20 Institutional controls are non-engineering solutions used at hazardous waste sites to prevent public access to contaminated ground water, surface water, or soils. Institutional controls include deed restrictions, easements, purchases of land and/or water systems, and reliance on State and local laws (e.g., zoning laws and laws regulating drilling and operation of drinking-water wells).

21 See footnote 3.

TABLE 2 - 1

ALTERNATIVES TO LAND DISPOSAL AS APPLIED TO WASTE MATRICES AT REMOVAL ACTIONS

DRUMMED LIQUIDS

Chemical reaction and neutralization
Detonation
Fixation and neutralization
Incineration
Neutralization
Recycling
Solidification

DRUMMED SOLIDS

Detonation
Recycling
Treatment

GAS MIGRATION

Carbon filtration on borehole
Detonation
Detonation of gas cylinders
Ventilation system
- ventilation and flaring of methane
- including air conditioning
- radon reduction system including air conditioning

GROUND WATER

Airstripping
Carbon filtration
Ion exchange filtration/distillation
Treatment
Treatment-recirculation

SOLIDS

Chemical degradation with acids
Incineration
- off site
- on-site infrared/thermal destruction
- on-site rotary kiln
- mobile incineration (Denny Farm)

Treatment

TABLE 2 - 1 (Continued)

SURFACE WATER

Carbon filtration
Commercial wastewater treatment
Oil/water separation
Sorbent booms
Treatment

These technologies have been applied to the waste matrices listed at removal actions since the beginning of the Superfund Program. This information is based on data in the ERD Removal Tracking System.

TABLE 2 - 2

ALTERNATIVE TREATMENT TECHNOLOGIES WITH POTENTIAL FOR USE AT REMOVAL ACTIONS

GAS MIGRATION

Chemical treatment
Recycling/recovery

GROUNDWATER

Carbon-steel electrodes
Granular activated carbon adsorption
In-situ biodegradation
In-situ bioreclamation
In-situ treatment (vacuum extraction process)
Recycling/recovery (distillation and reclamation)

LEACHATE

Activated carbon adsorption
Aerobic biological treatment
Centrifugation
Dechlorination
Distillation
Encapsulation
Filtration
Fixation
Fixed film fluid bed reaction
Fluidized bed combustion
Fluidized bed combustion (circulating bed combustion)
Granular activated carbon adsorption
In-situ biodegradation
Ion exchange
Microscreening
Neutralization
Oxidation/reduction
PCB dechlorination
Powdered activated carbon
Precipitation
Pyrolytic reaction
Recycling/recovery (distillation & reclamation)
Rotary kiln incineration
Soil washing
Solidification
Stabilization

TABLE 2 - 2 (Continued)

SOLIDS

Centrifugation
Chemical treatment
Chemical dechlorination
Dewatering
Encapsulation
Extraction/soil flush-wash
Filtration
Fixation
Fluidized bed combustion
Mobile infrared incineration
Neutralization
Oxidation
Oxidation/reduction
Powdered activated carbon
Precipitation
Pyrolytic reaction
Recycling/recovery
Rotary kiln incineration
Soil washing
Solidification
Stabilization

SOILS

Centrifugation
Chemical treatment
Dechlorination
Dewatering
Encapsulation
Extraction/flush-wash
Filtration
Fluidized bed combustion
In-situ biodegradation
In-situ bioreclamation
In-situ treatment
- vacuum extraction process
- soil vitrification

Mobile infrared incineration
Neutralization
Oxidation
Precipitation
Pyrolytic reaction
Rotary kiln incineration
Soil washing
Solidification
Stabilization
Volatilization (mobile solids roaster/dryer)

TABLE 2 - 2 (Continued)

SURFACE WATER

Oxidation/reduction

WASTE WATER

Activated carbon filtration
Adsorption
Aerobic biological treatment
Carbon-steel electrodes
Centrifugation
Chemical dechlorination
Dewatering
Distillation
Encapsulation
Filtration
Fixation
Fixed film fluidized bed reaction
Fluidized bed combustion
Granular activated carbon adsorption
In-situ biodegradation
Ion exchange
Microscreening
Neutralization
Oxidation/reduction
PCB dechlorination
Powdered activated carbon
Precipitation
Pyrolytic reaction
Recycling/recovery (distillation & reclamation)
Rotary kiln incineration
Soil washing
Stabilization

This is by no means an exhaustive list. Technologies not listed can also be considered.

minimum, identify this technology and evaluate it in the screening step (Section 2.4). It is possible, however, that the BDAT would fail the screening and not be considered further in the detailed analysis. For example, many CERCLA wastes are mixtures and it may not be technically feasible to apply certain BDATs to these wastes. If the OSC/RPM believes that the specified BDAT may not work on the site wastes, or that other technologies may achieve the same level of performance and be more appropriate for the wastes on site, additional treatment technologies may be identified in the EE/CA.

For the EE/CA report, all applicable technologies should be included. While the consideration of a particular technology may be minimal, it and all other appropriate technologies should be listed in order to show that they were considered. In some cases, it may be helpful to consider only a category of technology, such as incineration, rather than listing all the specific types of incineration that may be applicable as separate technologies (e.g., rotary kiln, fluidized bed). If on-site incineration is considered inappropriate because the site is in a residential neighborhood, it may then be possible to screen out all types of incineration at one time as one technology category (under institutional considerations), rather than screening each type separately.

2.4 INITIAL SCREENING OF REMOVAL ACTION ALTERNATIVES

Each technology will be subjected to a screening for fundamental characteristics that may eliminate it from further consideration, using the following screening factors:

- The public health and environmental protection provided by the technology;
- The ability of the technology to produce the desired results in the stipulated time frame;
- The feasibility of the technology; and
- The acceptability of the technology in light of institutional considerations.

The purpose of the screening is to eliminate technologies with obvious "fatal flaws" up front, so they do not have to be carried through the detailed analysis. If an alternative fails one of the four screening tests, it need not be subjected to the other

screening criteria. However, the reason(s) for eliminating the technology must be documented.

The EE/CA report can present the results of the screening process in narrative and/or table form. A useful format for presenting the information in table form might also be to list the alternatives along one axis and the screening criteria along the other axis, and to indicate with an "x" or a "yes-no" whether the alternatives satisfied each criterion. A narrative accompanying the table can explain the major findings.

Another option for performing the screening process is to use a scoring system with different points assigned to each option, depending on how well it satisfied each screening criterion. An example of such a scoring process is presented in Table 2-3. Under such a system, any alternative that received a "1" in any category should generally be eliminated from further consideration. Alternatives with the lowest total scores could also be eliminated. It should be stressed that such scoring systems are intended only for assisting the OSC/RPM in identifying reasons why an alternative is or is not appropriate. The final determination should be based primarily on logical, well-founded arguments, and not solely on the point system.

The following discussion presents general guidelines on how to use the four screening criteria to eliminate obviously inappropriate technologies.

2.4.1 Public Health and Environmental Protection

The first step of the screening evaluates the degree to which technologies will effectively mitigate threats to public health and the environment. The technologies should be categorized and rated in a consistent manner. Questions to be considered include:

- Does the technology protect public health and the environment?
- Will the technology provide ultimate long-term mitigation of threats to public health, welfare, and the environment?
- Are there any potential long-term threats posed by the technology? What is the severity of the threats?

TABLE 2 - 3

SCREENING FACTOR RATING SCHEME

	Criteria	Rating Points
1.	Does the option protect public health and the environment?	
	Option will provide ultimate long-term mitigation of threats to public health, welfare and the environment.	4
	Option will mitigate threats to public health, welfare and the environment but long-term future threats may occur due to failure.	3
	Option will mitigate threats to public health, welfare and the environment but long-term future threats are likely due to failure.	2
	Option does not mitigate threats to public health, welfare and the environment.	1
2.	Can the option be implemented within the time limits imposed by the situation?	
	Yes	4
	No	1
3.	Is the option technically feasible in light of the situation?	
	Option is proven technically feasible in large field-scale applications under similar site conditions, media, and contaminants.	4
	Option is proven technically feasible in large field-scale applications under different site conditions.	3
	Option is not proven technically feasible in large field-scale applications.	2
	Option is not proven technically feasible, i.e., it has failed under similar site conditions, media, and contaminants or is an emerging technology.	1

TABLE 2 - 3 (Continued)

4.	What are the institutional considerations?	
	Consistent with NEPA, extremely positive public perception, or minimal institutional requirement concerns.	4
	Consistent with NEPA, acceptable public perception, or some institutional requirement concerns.	3
	Consistent with NEPA, negative public perception, or major institutional requirement concerns.	2
	Inconsistent with NEPA, negative public perception, or major institutional requirement concerns.	1

In order for a technology to be considered further it must ensure, at a minimum, short-term mitigation of site threats. However, short-term mitigation of threats should be avoided to the extent possible where there are no plans for another party to provide longer-term remediation. For example, encapsulation of 45 cubic yards of asbestos tailings located in a playground is technically feasible because encapsulation would eliminate exposure in the short-term. However, because of potential long-term hazards posed by the presence of the asbestos and the possibility that it would be uncovered, the technology may not be considered acceptable and may be screened out.

2.4.2 Timeliness

A screening of technologies based on ability to mitigate the threat in a timely manner should consider both technology-specific and site-specific factors. Technology-specific timing factors are the characteristics associated with a particular technology that are not affected by local site conditions. Examples of technology-specific factors include timeliness of the approval process for that technology, contracting considerations, mobilization times, testing requirements, and time until capacity is available. Use of innovative technologies, for example, may require significant lead time for Headquarters approval and site-specific contracting. Site-specific timing factors are those factors that are dependent on the specific nature of the site and its wastes. Site-specific factors include the amount and type of wastes, as well as the physical location of the site. For example, if a site is in a remote area, a technology that requires heavy equipment may need extra lead time to build an access road to the site.

The expected lead times associated with each technology should be compared to the scheduling objectives established in Section 2.2.3. Technologies that cannot be implemented in a timely manner, based upon this preliminary screening, should be eliminated from further consideration.

2.4.3 Technical Feasibility

The purpose of the technical feasibility screen is to eliminate consideration of candidate technologies that may not be technically practicable based on the goals and restrictions of the removal program, and on the evaluation of major technical flaws. For example, emerging technologies (i.e., technologies that have not developed beyond

laboratory or pilot-scale testing) may be identified, but because removal cleanup funds may not be used to fund emerging technologies, they should be eliminated during the screening process.[22] In another situation, an available technology may be excluded from further consideration if it is deemed applicable for the type of waste on site, but inappropriate due to site-specific conditions. Some of the questions that may be asked when assessing technical feasibility are:

- Has the technology been proven in large, field-scale applications?
- Has the technology been used on similar site conditions, media, and contaminants?

In addition, for wastes restricted under LDR, the screening may include consideration of whether the technology will meet the LDR treatment standard. In particular, for restricted wastes that must be treated using a specified BDAT, the screening may be used to evaluate whether the specified BDAT is appropriate for the wastes on site, or whether alternative treatment methods must be considered.

2.4.4 Institutional Considerations

Institutional considerations take into account the potential public response to use of the technology, the need for permits, the adherence to applicable laws, the concerns of other regulatory agencies, and compliance with other removal action requirements. Questions that may be addressed include, but are not limited to:

- Will the public accept the technology?
- Does the technology require acquisition of permits?
- Is the technology able to comply with essential ambient/chemical specific and locational ARARs?
- Does the technology require the cooperation of other agencies or organizations? For example, are political boundaries being crossed, will land need to be acquired, and are zoning variances required?

---

[22] Emerging technologies, however, may be candidates for the Superfund Innovative Technology Evaluation (SITE) program.

- Will the cost and duration of the technology remain within the $2 million/12 month statutory limits? If not, is the site likely to qualify for an exemption?
- Does the technology contribute to the efficient performance of long-term remedial action at the site?
- For off-site options, does the alternative comply with the Off-site Disposal Policy?[23]

Each technology and each site will have a different set of concerns depending upon the setting and the public perception of the response actions. At this point, all institutional requirements need not be considered. The purpose of the screening is to identify any obvious "fatal flaws." The remaining institutional considerations should be evaluated in the analysis of those removal options that survive the screening.

2.5 ANALYSIS OF REMAINING REMOVAL ACTION ALTERNATIVES

The alternative technologies that have passed the initial screening must undergo a more detailed analysis in order to select the technology to be implemented. The selection process begins with the identification of the action-specific ARARs for each alternative, followed by a four-step analysis of each alternative. The analysis consists of application of the following selection criteria:

- Technical feasibility;
- Reasonable cost;
- Institutional considerations; and
- Environmental impacts.

With the exception of the cost criterion, all of the criteria have been discussed in the previous section. For purposes of documenting the analysis, the EE/CA report should include narrative sections discussing each of the selection criteria for each alternative. The evaluation methods may entail an in-depth discussion, a grading approach, or a determination of the advantages and disadvantages of the technology. Supplementary

---

[23] See memorandum from AA, OSWER to RAs, entitled "Procedures for Planning and Implementing Off-Site Response Action," May 6, 1985, and Chapter ___ of the Superfund Removal Procedures.

use of tables, diagrams, scoring systems, and other analytical and presentation methods is encouraged. An example of a scoring approach is presented in Table 2-4. The following sections discuss the increased level of detail required in the analysis of each technology.

2.5.1 Identification of Action-Specific ARARs

Action-specific ARARs should now be identified. (LDR requirements, however, are identified in Section 2.2.4.) Again, the appropriate State ARARs should be developed in consultation with the appropriate State representative. This section of the EE/CA report should only list the action-specific ARARs for each alternative, for easy reference. Compliance with the ARARs should be discussed as part of the analysis of technical feasibility, institutional considerations, or environmental impacts, as appropriate. The compliance discussion should also address the ability of each alternative to achieve those ambient/chemical-specific ARARs and locational ARARs (identified in Section 2.2.4) not previously addressed in the screening process. The EE/CA should thoroughly document the reason(s) for not achieving compliance with any identified ARARs.

2.5.2 Technical Feasibility

Several issues must be addressed when evaluating the technical feasibility of an option. They include, but are not limited to: effectiveness, useful life, operation and maintenance, demonstrated performance, and constructability. Each of these issues is described below.

Effectiveness

The technology should be evaluated in terms of its ability to perform intended functions such as containment, diversion, removal, destruction, treatment, or disposal. The effectiveness evaluation should also take into account the ability of the technology to comply with identified ARARs. For example, for LDR-subject wastes, the ability of the technology to achieve treatment standards should be a major factor in the analysis.

TABLE 2 - 4

TECHNOLOGY/SELECTION CRITERIA

1. TECHNICAL FEASIBILITY

Criteria	Rating Points
A. Effectiveness	
Destroys hazardous substances.	4
Prevents release of hazardous substances; contaminants are isolated but not eliminated.	3
Minimizes the release of hazardous materials; adequately protects public health and environment.	2
Allows or promotes release of hazardous substances; ineffective.	1
B. Demonstrated Performance	
Proven reliable in the field under similar conditions on the same waste material; widely demonstrated to be effective.	4
Proven reliable in the field under similar conditions on similar waste materials.	3
Proven reliable, but under different conditions and materials; limited experience and reliability.	2
C. Useful Life	
Permanent; irreversible	4
Long-term, potentially reversible; effectiveness decreases with time with a low probability of release.	3
Long-term, potentially reversible with a high probability for release.	2
Short-term solution; difficult to repair or replace upon failure; temporarily mitigates hazards; long-term abilities questionable.	1

TABLE 2 - 4 (Continued)

D. Environmental Effects Upon Operations

Performs well under all environmental conditions.	4
Performs well under most environmental conditions.	3
Performs adequately under most conditions.	2
Susceptible to adverse weather conditions.	1

2. REASONABLE COST

3. INSTITUTIONAL CONSIDERATIONS

A. Permitting and Other Factors Affecting Start-Up

No permitting or significant lead time required.	4
Minimal lead time required (3 months).	3
Moderate lead time required (6 months).	2
Significant lead time required (1 year).	1

B. Time to Complete

Can be completed within the 12 month statutory limit.	4
Site is expected to qualify for an exemption to the 12 month limit, and alternative can be completed within a reasonable time thereafter.	3
Site is expected to qualify for an exemption, but requires significant time beyond the 12 month limit to complete.	2
Cannot be completed within the 12 month statutory limit, and the site is not expected to qualify for an exemption.	1

TABLE 2 - 4 (Continued)

C. Safety

1) During Installation/Operation

Very safe; requires no more than normal safety procedures required for workers at hazardous waste sites; no threat to surroundings at any time.	4
Safe; requires few safety procedures other than those normally required at a hazardous waste sites; minor threat to adjoining residential areas may occur.	3
Hazardous; requires stringent safety procedures to ensure worker safety; may require evacuation of homes near the site.	2
Very hazardous; requires remote operation and evacuation of area homes.	1

2) Effects of Failure

Very safe; redundant controls prevent hazardous substance release.	4
Failure results in hazard that is less than that presented by the site prior to the removal action.	3
Failure results in hazard that is approximately equal to that presented by the site prior the removal action.	2
Failure results in hazard greater than that presented by the site prior to the removal action.	1

D. (Other relevant institutional considerations may be added.)

4. ENVIRONMENTAL IMPACTS

Positive environmental impact.	4
No detrimental environmental impact.	3
Minimal adverse environmental impact.	2
Extreme adverse environmental impact.	1

The effectiveness of the technologies should be determined either through design specifications or by performance evaluation. Any special site or waste conditions that affect performance should be considered and the design should be tailored to accommodate those conditions. Preference should be given to those technologies that completely immobilize, destroy, or recycle the hazardous substances.

Useful Life

The technology should be evaluated in terms of the projected service life. Many technologies deteriorate with time (e.g., erosion of clay cap). While deterioration can be slowed or reduced through proper operation and maintenance, any systems or structures may eventually require replacement.

Operation and Maintenance Requirements

Evaluation of operation and maintenance (O&M) should emphasize the availability of labor and materials as well as their costs. In addition, the frequency and complexity of necessary operation and maintenance over the full life of the project should be considered when evaluating reliability. Technologies that require frequent or complex operation and maintenance should be regarded as less reliable than technologies requiring little or straightforward operation and maintenance.

Demonstrated Performance

The analysis of technologies should not be based on the presumed performance of untested methods. Preference should be given to technologies that have proven effective under similar site conditions and with similar contaminants. Consideration should be given to innovative processes that have been proven dependable in the field. It is important to identify when a technology has been tested in pilot studies, but has not performed well in the field under certain conditions (e.g., climate, etc.).

Environmental Conditions

Environmental conditions, such as terrain and climate, should be considered when evaluating a technology. Climate may affect the performance of a proven technology.

For example, special operational devices, such as heaters, may be needed if an oil/water separator is to be used during winter months when freezing temperatures become a problem. Terrain may also affect performance. For example, a technology that discharges particulates into the ambient air may require the presence of prevailing air currents to disperse the emissions. A site located in a mountain valley may pose a problem for the technology because the surrounding air currents provide insufficient dispersion of the particulates.

Constructability

Site-specific characteristics that could delay or prohibit construction and implementation of a proposed technology must be assessed. For example, the inaccessibility of a site or the presence of a large number of trees in the contaminated area may significantly delay implementation of a technology. Certain technologies that require zoning clearances and local permits could delay or prohibit implementation. (Such requirements may be discussed here or as part of the analysis of institutional considerations.) Implementation times should be estimated and provide for weather conditions, unanticipated site conditions, and necessary safety precautions. Technologies should be evaluated in terms of the most likely construction schedule, based on experience at similar sites.

The time to achieve beneficial results must also be evaluated. Certain technologies provide immediate results, while others may take months. Beneficial results may be defined as the reduction in levels of contamination necessary to attain public health and environmental standards established as objectives for the site.

Summary

The primary consideration in discussing the technical feasibility of a technology is whether the technology is reliable and appropriate for the site situation. Key items to be addressed include:

- How effectively does the technology eliminate or mitigate the hazards?
- How long is the solution anticipated to maintain its integrity (useful life)?
- How difficult is the technology to operate and maintain?

- What is the history of the performance of the technology?
- How do environmental conditions affect the operation of the technology?
- How easily may the technology be constructed?

The amount of uncertainty associated with the technology, especially for innovative technologies, should be noted in the discussion.

2.5.3 Reasonable Cost

Detailed cost analyses should be performed for each of the alternatives being considered. To analyze project costs, the OSC/RPM must perform the following two steps and may perform an optional third step:

1. Estimate the capital and operation and maintenance costs.
2. Using the capital and O&M estimates, calculate the present worth.
3. Evaluate the sensitivity of each of the present worth calculations to changes in such parameters as the discount rate or the component costs, if appropriate.

2.5.3.1 Cost Estimation

The OSC/RPM should identify all capital and operation and maintenance costs for each alternative. The Removal Cost Management Manual provides guidance on developing cost projections. The following items are considered capital costs and operation and maintenance costs:

- Direct Capital Costs
  - Construction costs
  - Equipment and material costs
  - Land and site acquisition costs
  - Buildings and services costs
  - Relocation expenses
  - Transport and disposal costs
  - Analytical costs

- Indirect Capital Costs
  - Engineering and design expenses
  - Legal fees and license or permit costs
  - Startup and shakedown costs
  - Contingency allowances

- Operation and Maintenance Costs
  - Operational costs
  - Maintenance costs
  - Monitoring costs
  - Support costs

Many sources of cost information exist, including the ERCS contract price list, the "Remedial Action Costing Procedures Manual," September 1985 (OSWER Directive #9355.0-10), vendor estimates, and estimates for similar projects. For items not on the ERCS contract price list and for projects where outside bids are being considered, costs over a year old should be updated using an appropriate economic index, such as the Engineering News Record Construction Cost Index for construction costs, the Marshall and Stevens Index for treatment facility costs, the American City and County Municipal Cost index for manpower costs, and the Producer Price Index for Finished Goods, published by the U.S. Department of Labor in the Monthly Labor Review.

2.5.3.2 Present Worth Calculation

After the costs have been identified and estimated, the present worth must be calculated. Present worth analysis is used to evaluate expenditures that occur over different time periods by discounting all future costs, usually operation and maintenance costs, to a common base year, usually the present. Present worth analysis produces a single figure representing the amount of money that, if invested in the base year and disbursed as needed, would be sufficient to cover all costs associated with the alternative. For projects that will last less than one year (generally, projects that do not require operation and maintenance), the present worth is simply the one time cost of performing the action. In this case, the cash flow discounting method used to determine the present worth is not necessary. The present worth analysis is particularly important when comparing technologies with different operating lifetimes.

For example, present worth analysis allows comparison of a project that takes less than one year to complete (the present worth would be the one time cost with no discounting required) with a project that takes three years to complete (with all future costs discounted to the present). Appendix C provides a detailed explanation of how to perform a present worth analysis. For the purposes of the EE/CA report, the final present worth figure and the assumptions used in calculating that figure should be included in the text. The detailed computations should be attached as an appendix to the report.

In conducting the present worth analysis for projects longer than 1 year, assumptions must be made regarding the discount rate. As outlined in OMB Circular No. A-94, a discount rate of 10 percent before taxes and after inflation should be assumed. This rate represents the average rate of return on private investment.

For alternatives that include operation and maintenance after one year, two present worth analyses must be performed. The first analysis should calculate the total cost of the option over the full life of the project (see Appendix C). The second analysis should calculate the total cost of the option to the removal program for one year, assuming that all operation and maintenance costs will be assumed by another party after one year. For purposes of comparing alternatives, the cost of the option to the removal program for one year should be used for those projects that require long-term operation and maintenance.

2.5.3.3 Sensitivity Analysis

After the present worth of an alternative is calculated, the OSC/RPM may choose to determine the effects of variations in the cost assumptions through a sensitivity analysis. A sensitivity analysis assesses the effect that variations in specific assumptions associated with the design, implementation, operation, discount rate, and effective life of an alternative can have on the present worth. It is recognized that many components of a removal action, such as the cost of transport, the effective life of an alternative, or future operation and maintenance costs, as well as external factors such as the discount rate, are subject to a great degree of uncertainty. The sensitivity of these costs to uncertainties can be observed by varying the cost assumptions and noting their effect on the present worth. Performing a sensitivity

analysis might be appropriate in situations where the OSC/RPM is unsure of the amount of wastes present, the time it will take the wastes to be destroyed, or fluctuations in the future price of cleanup services. An example of how changes in the discount rate could affect the decision as to which technology would be more or less costly is presented in Example 3 of Appendix C.

2.5.4 Institutional Considerations

Institutional considerations to be assessed in this step of the selection process should elaborate further on the factors presented in Section 2.4.4. Some of these factors may not be relevant for a particular alternative. The discussion or ranking may include the following:

- Ability of the technology to achieve the objectives established in Section 2.2:
  - Statutory limits on removal actions
  - Removal scope (including contribution to the efficient performance of any long-term remedial action)
  - Removal schedule
  - Compliance with ARARs (any ARARs not otherwise addressed under "technical feasibility" or "environmental impacts");
- State and local concerns about the technology;
- Necessary cooperation of other agencies;
- Permitting requirements;
- Safety of the technology during operations and upon failure;
- Possible transportation of hazardous materials;
- Impacts of the technology on adjoining property use or value;
- For off-site options, compliance with the Off-Site Disposal Policy.

2.5.5 Environmental Impacts

The fifth stage of the alternatives analysis is to determine environmental impacts. This analysis may be used to fulfill the equivalency requirements for an environmental impact analysis as mandated under NEPA. Alternatives that qualify for a Generic

Exclusion do not require an environmental impact analysis.[24] However, a statement should be included to indicate that the alternative qualifies for this exemption.

The first step in developing an environmental impact analysis is to identify what environmental media will be impacted, both adversely and beneficially, through implementation of each alternative being considered. Environmental effects of removal actions may, for example, influence hydrology, geology, air quality, water quality, biology, land use, or archaeological or historic sites.

After the impacted media have been identified, the next step is to determine the direct effects of the action. Direct effects may be adverse or beneficial. Direct adverse effects may result from construction activities, from stabilization following completion of the construction, or from implementation of the alternative. Direct beneficial effects include mitigation of the existing threat. Indirect adverse or beneficial results of the alternative, such as effects on the economy of the area or on human migration patterns, generally should not be discussed unless warranted by special circumstances.

It is necessary to identify and evaluate any expected direct adverse effects of construction and operations. Adverse effects might include contamination of air resulting from on-site incineration, runoff into surface water from excavation of contaminated soil, or destruction of wetland areas in construction of an access road to the site. The OSC/RPM should especially consider sensitive environmental areas and resources that people use (e.g., commercial use, recreational use), and distinguish inevitable effects from merely possible effects so that the evaluation of alternatives can estimate the probability of expected adverse effects. Equally important is recognizing that some effects are irreversible. It is important to note which significant adverse effects are reversible or irreversible.

In general, each alternative should also be evaluated by considering direct beneficial effects of the response, such as changes in the release of contaminants and final environmental conditions, improvements in the biological environment, and improvements in the resources that people use. Beneficial effects should be measured primarily by

---

[24] See the removal program policy on compliance with NEPA, "Environmental Review Requirements for Removal Actions" (see footnote 4).

the impact of the removal alternative on concentrations of contaminants in each environmental medium of concern, and the time required to reach desired levels. The ambient residual contamination predicted for an alternative should be compared to relevant ARARs. Because the ARARs criteria may have been set under different conditions, it may be necessary to examine current site conditions and determine if the standards are actually suitable.

Consideration should include, but not be limited to, the following resources and their associated standards:[25]

Surface water - Removal action alternative technologies can impact surface waters through direct discharge into the surface water or oceans, indirect discharge to publicly-owned treatment works (POTWs), and discharge of dredge or fill material into waters of the U.S., including wetlands. The Clean Water Act (CWA) establishes five categories of standards to control direct and indirect discharge of pollutants. These regulations include technology-based standards, water quality standards, ocean discharge standards, pretreatment standards, and dredge and fill discharge standards.

Technology-based standards are effluent guideline limitations for a specific industry or industrial category, based on the best available technology economically achievable (BAT) for toxic pollutants and the best conventional pollutant control technology (BCT) for conventional pollutants (i.e., biochemical oxygen demand, pH, total suspended solids, fecal coliform, and oil and grease). For removal actions where no specific industry exists, technology-based effluent limitations have to imposed on a case-by-case basis. Therefore, best professional judgment is used to identify applicable BCT/BAT equivalent discharge limitations (regulated at 40 CFR 405-471).

Water quality standards establish goals for specific water bodies and also serve as the basis for water quality-based controls beyond the technology-based levels of treatment required by Sections 301(b) and 306 of the CWA. A water quality standard consists of two major parts: (1) specification of designated use (or uses)

---

[25] More detailed information on each of the legal requirements discussed in this section can be found in the "CERCLA Compliance With Other Laws Manual" (see footnote 16).

that considers the water body's value for public water supplies; propagation of fish, shellfish, and wildlife; recreational use; navigation; and agricultural, industrial and other purposes; and (2) numerical and/or narrative standards to protect the designated use.

The revised water quality standard regulations (40 CFR 131; 48 FR 51400, November 8, 1983 and subsequent notices) emphasize criteria for toxic pollutants in State standards as the basis for permit limitations under the National Pollutant Discharge Elimination System (NPDES). Most State standards do not include numerical criteria for many toxic chemicals. Instead, States utilize narrative water quality standards to prevent the discharge of "toxic material(s) in toxic amounts." If States promulgate numerical standards for toxic chemicals, the standards are usually based on National Ambient Water Quality Criteria (NAWQC) but may be more stringent than EPA water quality criteria to protect designated uses. Criteria and standards for the NPDES are at 40 CFR 125.

Discharges into oceans are subject to specific environmental impact prohibition and limits, and conditions of materials, established at 40 CFR Subchapter H (220-223).

General pretreatment regulations (40 CFR 403) describe general and specific prohibitions to control the introduction of pollutants into POTWs. The goal of the regulations is to protect POTWs and the environment from damage that may occur when hazardous, toxic, or highly concentrated wastes are discharged into a sewer system. In addition, States and local communities may impose limitations and discharge prohibitions which are considered pretreatment standards.

Direct discharge of dredge and fill into surface waters is specifically regulated in CWA Section 404 (the "404 Program") and implemented under 40 CFR 230 and 33 CFR 320-330. EPA may prohibit the discharge of dredge material if adverse environmental effects are expected, including the violation of applicable water quality standards. Protecting wetlands is one of the primary goals of the 404 Program.

Groundwater - For the most part, removal actions do not attempt to reduce contamination levels in groundwater due to time and cost constraints. A

groundwater classification system has been developed by the EPA Office of Groundwater Protection. Groundwater is placed in one of three classification categories (I, II, or III) based on ecological use, replaceability, and vulnerability. The classification system and accompanying "Guidelines for Groundwater Classification"[26] provide a systematic procedure for obtaining site-specific information on groundwater and integrating this information into the determination of groundwater importance. This system, and any promulgated State groundwater classification systems, should be considered in the impact analysis.

Drinking Water - The drinking water standards established under the Safe Drinking Water Act of 1974 (SDWA) require that certain levels for microbial, inorganic, organic, and radionuclide contaminants be met. EPA has promulgated contaminant-specific ambient standards known as maximum contaminant levels (MCLs) for ten inorganics, six organic pesticides, total trihalomethanes, certain radionuclides, and coliform bacteria (40 CFR 141). MCLs are enforceable standards based upon consideration of adverse health effects of a contaminant, available treatment technologies, and costs of treatment. Maximum contaminant level goals (MCLGs), in contrast, are strictly health-based and are considered non-enforceable health goals. MCLGs have been developed for eight organic contaminants and for fluoride. The Safe Drinking Water Act Amendments of 1986 require EPA to promulgate MCLs for 83 specific contaminants by June 1989. A list of currently proposed MCLs and MCLGs can be found at 50 FR 46902 and 46936, November 13, 1985.

Under the Safe Drinking Water Act Amendments of 1986, States are mandated to develop within three years, programs to protect wells that supply public drinking water systems from contaminants that flow into the wells from the surface or sub-surface. State wellhead protection programs may contain requirements for protecting a municipal water source or replacing it if contaminated. The Office of Groundwater Protection or States should be contacted for applicable standards.

In addition, RCRA maximum concentration limits for 14 toxic compounds have been adapted as part of RCRA groundwater protection standards (40 CFR 264.94).

---

[26] See "Draft Guidelines for Groundwater Protection Classification Under the EPA Groundwater Protection Strategy," Office of Groundwater Protection, February 1986.

Soils - Two general types of threats should be considered when developing criteria for soils: (1) direct contact by intruders onto the site, and (2) contamination of other environmental media by soils. Unfortunately, there are no currently promulgated Federal environmental criteria or standards for contaminants in soil, except PCBs. (PCBs are regulated under the Toxic Substance Control Act at 40 CFR 761. The TSCA-issued, "Polychlorinated Biphenyls Spill Cleanup Policy", 52 FR 10688-10710, April 2, 1987, defines cleanup standards for certain PCB spills into various media.) In the past, however, the Agency for Toxic Substances and Disease Registry (ATSDR) has set action levels for certain chemicals.

Air - Removal activities can impact the air through chemical pollution and noise pollution. Chemical pollution can result from incineration, release of gases from chemical reactions, or volatilization of chemicals during soil excavation or movement. Emission standards and exemptions promulgated under the Clean Air Act, including State air quality implementation plans, may be found at 40 CFR 61-69. Noise pollution can be contributed by transportation, construction, and on-site treatment equipment. Subchapter G, 40 CFR - Noise Abatement Programs, and 24 CFR 51 - the Use of Day-Night Average Noise Levels, should be incorporated when applicable. It is not expected that noise pollution will be a frequent problem at removal sites.

In addition to the protection of these general environmental resources, the analysis of alternatives should also consider the protection of other specific environmental and cultural resources as follows:

- Sole Source Aquifers - The SDWA permits EPA to designate aquifers that are the sole and primary drinking water source for an area, and which, if contaminated, would present a significant hazard to human health, as "sole source aquifers" (40 CFR 149). Plans demonstrating that the quality of groundwater and the protection of human health and the environment will be maintained must be submitted for Federally-financed projects affecting critical aquifer protection areas.

- Archaeological and Historic Resources - The National Historic Preservation Act of 1966 and the Preservation of Historical Archaeological Data Act of 1974

require that proposed actions account for effects on properties listed in, or eligible for, listing on the National Register of Historic Places, and that such actions minimize harm to significant historical and cultural resources. The Historic Preservation Advisory Council should be consulted to identify and determine the potential effects of proposed activities. Uniform regulations for the protection of archaeological resources have been promulgated by the Department of Defense (32 CFR 229), Forest Service (36 CFR 296), and the Department of the Interior (43 CFR 7). The Soil Conservation Service also provides for the protection of historical and archaeological properties encountered in implementing its programs (7 CFR 656).

- Wild and Scenic Rivers - The Wild and Scenic Rivers Act (36 CFR Part 297, section 7) provides for the protection of rivers designated as "wild and scenic, or recreational," and the land adjacent to such rivers. The construction of any dam, water conduit, reservoir, powerhouse, transmission line, or other project directly affecting any "wild and scenic" river is expressly forbidden by this Act. If a removal action will affect lands adjacent to a "wild and scenic" river, the agency head must enter into cooperative agreements with the U.S. Forest Service, and State or local officials for the management of the lands.

- Wetlands - Executive Order 11990 requests that government agencies establish policies and regulations to protect wetlands. Wetlands are unique ecosystems that are covered with non-flood waters during part of the year (refer to U.S. Fish and Wildlife Circular 39 (1956), and later revisions resulting from the National Wetlands Inventory for defined wetland areas). Such areas generally include swamps, bogs, marshes, and other low-lying areas. The wetlands serve as a habitat for many species of wildlife, aid in natural purification of water, and maintain and recharge groundwater sources. Applicable regulations have been promulgated by the Department of Agriculture (7 CFR 1940), the Federal Emergency Management Agency (44 CFR 9), the U.S. Army Corps of Engineers (33 CFR 320-330), and EPA (40 CFR 230-233).

- Floodplains - Executive Order 11988 establishes a policy for floodplain management. Identification and mapping of flood plains and special flood-related erosion are covered at 44 CFR 65. One-hundred year floodplains are

designated on Flood Hazard Boundary maps and Flood Insurance Rate maps prepared by the Department of Housing and Urban Development. Land management and use criteria are discussed at 44 CFR 60. Because of the interrelationship between wetlands and floodplains, the references listed above also apply.

- Coastal Zones - The Coastal Zone Management Act of 1972, as amended at 216 USC 14.51, et seq., requires that any activities affecting land or water uses in the coastal zone of a State or territory be coordinated with the appropriate State agency responsible for administering the State's approved coastal management program.

- Critical Habitats of Threatened and Endangered Species - The Endangered Species Act of 1973 requires that proposed Federal actions avoid jeopardizing the continued existence of listed endangered species, or modification of their habitats. The Secretary of the Interior has determined that certain habitats are critical to the continuing existence of threatened or endangered species, and has developed a list of designated habitats for wildlife, plants, marine mammals, and fish to be protected (50 CFR 17 and 50 CFR 226-227). The U.S. Fish and Wildlife Service should be consulted for more detailed information concerning endangered or threatened plant and animal species and their habitats. The Fish and Wildlife Coordination Act (16 USC 661 et seq.) also protects fish and wildlife from actions that may modify natural streams or any body of water. If a removal action impounds, diverts, or deepens the channel of any stream or body of water, EPA must first consult with the Army Corps of Engineers, U.S. Fish and Wildlife Service, and/or the appropriate State fish and wildlife agency to ascertain the impact on wildlife and develop mitigation measures if necessary.

- Prime and Unique Farmlands - Farmlands producing specific high-value food and fiber crops are defined at 7 CFR 657 and inventoried by the Department of Agriculture Soil and Conservation Service (SCS). The Farmland Protection Policy Act (7 CFR 658) outlines procedures to identify and take into account adverse effects of programs on preservation of prime and unique farmlands.

- Federal Parklands and Wilderness Areas - These are areas of recognized scenic, recreational, archaeological, or historical value. The Park Service Organic Act establishes the conservation of scenery, natural and historic objects, and wildlife in national parks, monuments, and reservations as a primary management objective. The Wilderness Act establishes the nondegradation, maximum restoration, and protection of wilderness areas as primary management goals. The Department of the Interior should be consulted if any impact relevant to these acts is possible as a result of proposed actions.

- National Forests and National Grasslands - The U.S. Forest Service is required by the Forest and Rangeland Renewable Resources Planning Act of 1974 and the National Forest Management Act of 1976 to prepare Federal and regional management plans. The effects of a proposed technology on these plans should be evaluated.

Appendix D lists, by Region, the telephone number of the EPA section or branch responsible for preparing EPA-lead Environmental Impact Statements (EISs). The section staff can provide the OSC/RPM guidance on the environmental resources that need to be considered, and the appropriate agency to contact if a removal alternative will affect these resources. The Army Corps of Engineers has also developed procedures for preparing EISs (33 CFR 230) which may be helpful.

Improvements in resources used by people should also be considered and discussed. Many of these resources directly affect the welfare of local communities. The OSC/RPM should note the ability of alternatives to protect actual and potential human uses of resources, especially commercial, residential, aesthetic, and cultural uses.

Findings should be presented that allow comparison of the beneficial and adverse environmental effects of alternatives. In addition, the findings should identify mitigative measures to be taken for alternatives that appear to have significant inevitable or irreversible effects. The statement should also discuss the expected mitigating effects of the alternatives (e.g., percentage reduction in adverse effects). If success may be compromised by the mitigative measure, it should be noted and discussed.

2.5.5 Summary

When evaluating alternatives using the four selection criteria (technical feasibility, reasonable cost, institutional considerations, and environmental impact), the OSC/RPM must make subjective judgments as to the degree of importance each screening factor has relative to another screening factor. For example, an alternative may be the most technically feasible of all the alternatives being considered, but due to unreasonably high cost, may not be the most desirable alternative. The determination of whether one factor is more important than another is difficult to provide in guidance. If a scoring system, such as the one presented in Table 2-4, is used, the OSC/RPM may decide to emphasize the importance of one category over another by using a weighting factor. For example, if technical feasibility is deemed more important than institutional considerations, the score may be multiplied by a weighting factor. When all alternatives are summed, the bias will be toward those alternatives that are deemed more technically feasible. It must be stressed, however, that this method of evaluation is highly subjective and is intended only to help identify reasons why an alternative may be more or less desirable.

2.6 COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES

After each alternative is summarized individually, a comparative analysis of the advantages and disadvantages of each alternative weighed against those of the other alternatives should be performed. The comparative analysis describes the actual selection process. This analysis is particularly important when two or more technologies have similar characteristics, when one of the selection criteria is given greater weight in the analysis, or when a selected technology has significant disadvantages, but these are outweighed by its greater benefits. For the convenience of review, it is suggested that tables be used to supplement the comparative analysis in the EE/CA report. If scoring systems are used, they must be explained. Appendix E provides a sample of a comparative analysis in table form.

2.6.1 *Technical Feasibility*

Alternatives that result in the destruction of hazardous substances or in the reduction of the toxicity, mobility, or volume of the waste; are proven reliable in the field under similar conditions on the same waste materials; are widely demonstrated to be effective; have permanent and irreversible useful lives; and perform well under all possible environmental conditions at the site are preferred. Alternatives that are ineffective, unreliable, short-term, or susceptible to adverse site conditions are less preferred.

Note that the Region has the authority to select an available alternative technology with costs within the $2 million statutory limit. The use of innovative alternative technologies always requires Headquarters approval, regardless of the cost of the removal action.

2.6.2 Reasonable Cost

The reasonable cost criterion will be used to weigh the relative costs of alternative technologies that meet the objectives and selection criteria discussed above, and will help fulfill contracting requirements. The cost of removal actions is limited to $2 million by SARA, unless a statutory exemption is granted. Among similar alternatives, generally, those with the lowest present worth are preferred. However, technologies that are alternatives to land disposal and cost more than land disposal may be selected if justified.

Incremental differences in cost among the protective alternatives should be balanced against the benefits of meeting the objectives and other criteria. A more timely, more protective, or more technically feasible or institutionally feasible option may have a higher present worth than another alternative. To select a more costly removal alternative, the cost must be considered reasonable in the best professional judgment of the OSC/RPM, and with respect to contracting requirements.

2.6.3 Institutional Considerations

The comparative analysis should include discussion of how each alternative addresses the relevant institutional considerations relative to other alternatives. In general, the

OSC/RPM should strive to select alternatives that remain within, or exceed by a reasonable amount, the statutory limits on removal actions; meet the cleanup goals and schedule established in Section 2.2; contribute to the efficient performance of any long-term remedial action; and comply with ARARs to the maximum extent practicable. The other identified institutional concerns must also be weighed in the analysis.

2.6.4 Environmental Impacts

Alternatives that have positive environmental impacts are preferred.

2.7 RECOMMENDED REMOVAL ACTION ALTERNATIVE

The decision as to what alternative should ultimately be recommended lies with the OSC/RPM. This decision requires a combined consideration of all the selection criteria concerning the alternatives and the site itself, experience gained from previous similar situations, and best professional judgment. In particularly complex situations or where the OSC/RPM has no experience with a specific technology, the Regional Response Team (RRT) may be consulted.